Photocells

THEORY OF COMPONENTS USED IN MICROCONTROLLER-BASED PROJECTS

Overview

- Photocells are sensors that allow you to detect light.
- They are small, inexpensive, low-power, easy to use and don't wear out.
- They are often referred to as CdS cells (they are made of Cadmium-Sulfide), light-dependent resistors (LDR), and photoresistors.

- Photocells are basically resistors that changes their resistive value (in ohms Ω) depending on how much light is shining onto the surface.
- They have a resistance that falls with an increase in the light intensity falling upon the device.
- The resistance of an LDR may typically have the following resistances.
  - Daylight = 5000 ohms
  - Dark = 20000000 ohms

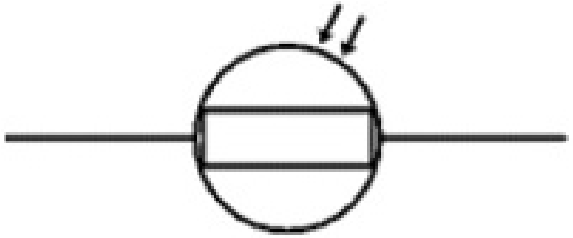

Fig 2a: Electrical Symbol of a photocell

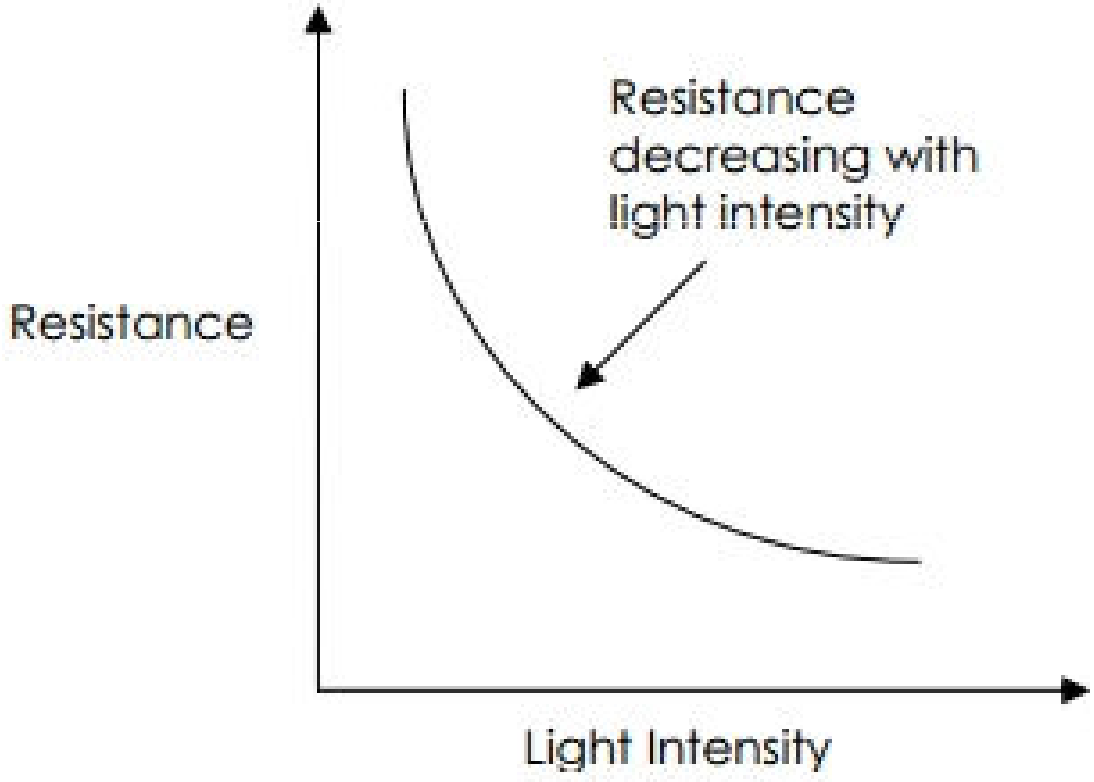

Fig 2b: A graph showing the rate of change of a photocell's resistance with light intensity

- Each photocell sensor will act a little differently than the other, even if they are from the same batch. The variations can be really large, 50% or higher!
- For this reason, they shouldn't be used to try to determine precise light levels in lux or millicandela. Instead, you can expect to only be able to determine basic light changes.

Basic Operating Principles

- An LDR is made of a high resistance semiconductor.
- In a semiconductor an energy gap exists between conduction electrons and valence electrons.
- If light falling on the device is of high enough frequency, a photon is absorbed and thereby it excites an electron from valence band into the conduction band.
- The resulting free electron (and its hole partner) conducts electricity; Due to such new electrons coming up in conduction band area, the electrical resistance of the device decreases.
- Thus the LDR or photoconductive transducer has the resistance which is the inverse function of radiation intensity.

Construction of a Photocell

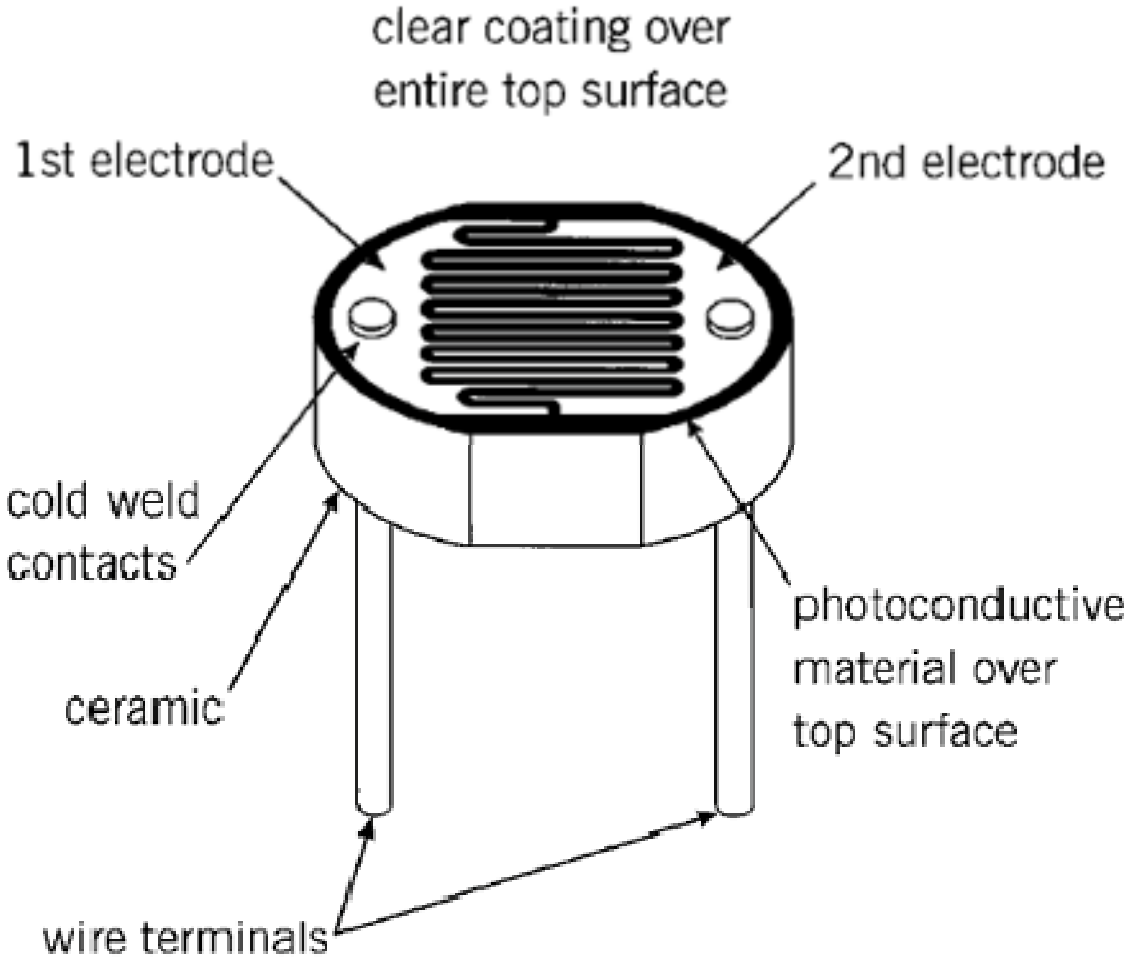

Figure 3
Typical Construction of a Plastic Coated Photocell

- There two common types of materials used to manufacture the photoconductive cells. They are Cadmium Sulphide (CdS) and Cadmium Selenide (CdSe).
- The band gap energy of Cadmium Sulphide is 2.42eV and for Cadmium Selenide it is 1.74eV. Due to such large energy gaps, both the materials have extremely high resistivity at room temperature. Hence, these materials are widely used in LDR for practical purpose.
- A long, thin and narrow strip of CdS is fixed on the surface of ceramic substrate in the form of zigzag wire as shown in figure 3. This construction gives minimum area and maximum length.
- Then the structure is enclosed in round metallic or plastic case and two terminals (made up of either tin or indium) are taken out for external connections. The structure is covered with glass sheet to protect it from moisture and dust and allows only light to fall on it.

Fundamental Photodiode Circuits

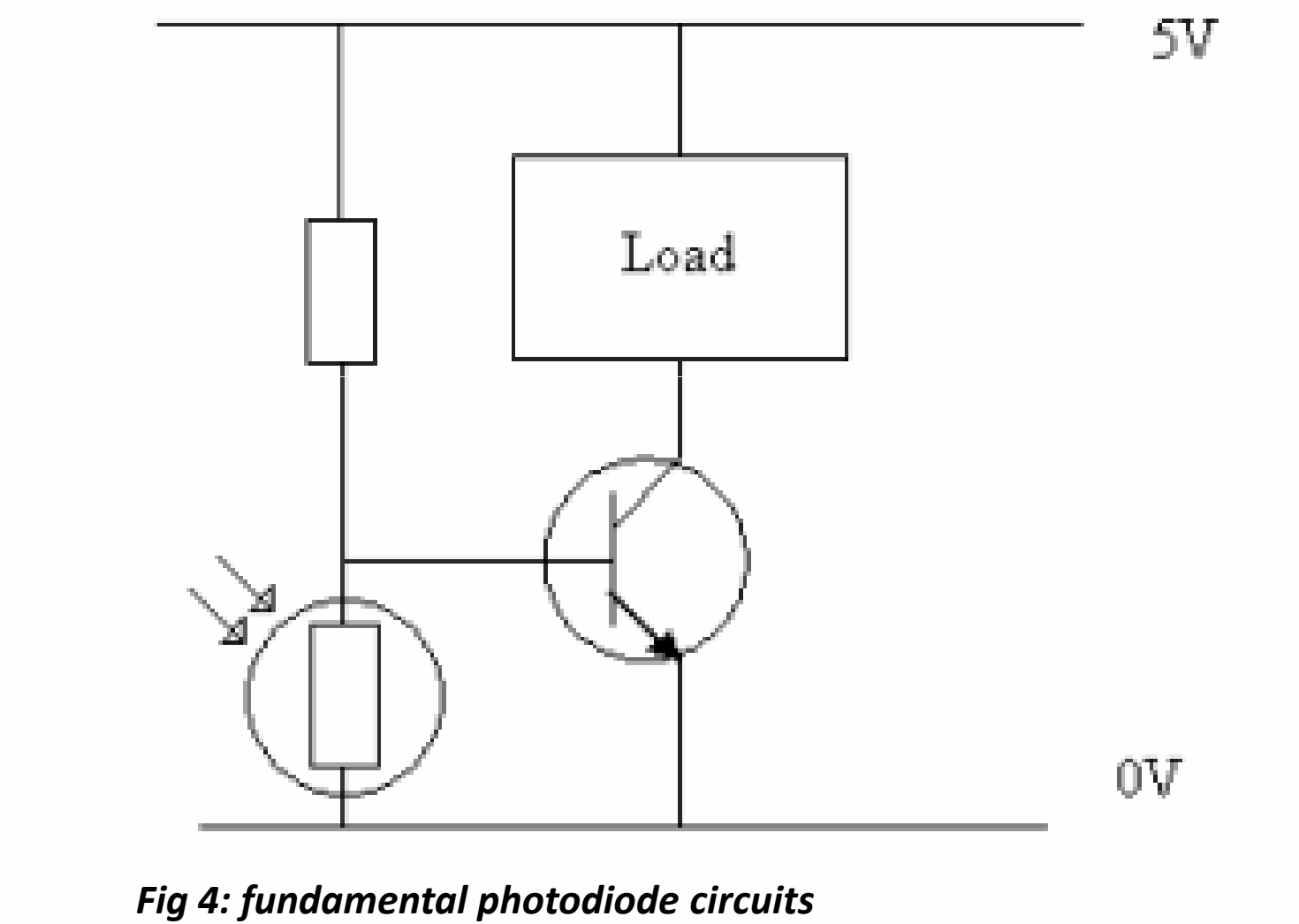

Fig 4: fundamental photodiode circuits

Figures 4 show the fundamental photodiode circuits.

- The circuit shown right shows a simple way of constructing a circuit that turns on when it goes dark. The increase in resistance of the LDR in relation to the other resistor which is fixed as the light intensity drops will cause the transistor to turn on. The value of the fixed resistor will depend on the LDR used, the transistor used and the supply voltage.

Applications

- It is used in burglar alarm to give alarming sound when a burglar invades sensitive premises.
- It is used in street light control to switch on the lights during dusk (evening) and switch off during dawn (morning) automatically.
- It is used in Lux meter to measure intensity of light in Lux.
- It is used in photo sensitive relay circuit.
- Other uses include in camera light meters, clock radios, outdoor clocks, and solar road studs, etc.
- They are also used in some dynamic compressors together with a small incandescent lamp or light emitting diode to control gain reduction etc.